AEC Report #SFIM-AEC-EQ-CR-99002
CERL Report #99/21

Dust Control Guidance and Technology Selection Key

U.S. Army Environmental Center

US Army Corps of Engineers®

May 1999

AEC Form 45, 1 Feb 93 replaces THAMA Form 45 which is obsolete.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	January 1999	Final; October 1996 - January 1999

4. TITLE AND SUBTITLE
Dust Control Guidance and Technology Selection Key

5. FUNDING NUMBERS

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U.S. Army Construction Engineering Research Laboratories
2902 Newmark Drive
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8. PERFORMING ORGANIZATION REPORT NUMBER

USACERL REPORT 99/21

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Environmental Center (USAEC)
Environmental Quality Division, Bldg E4435
Aberdeen Proving Ground, MD 21010-5401

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

SFIM-AEC-EQ-CR-99002

11. SUPPLEMENTARY NOTES

USAEC Project Manager: Ms. Kim Michaels (410)436-1573

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Although considerable research has been conducted by the U.S. Army Engineer Waterways Experiment Station, U.S. Army Construction Engineering Research Laboratories, product manufacturers, and other Federal and State agencies concerning dust control, results from this body of work have been published in a number of diverse and obscure documents that are largely unavailable or inaccessible to Army environmental, safety, public works, and natural resources managers. This lack of readily available information limits the ability of Army environmental, safety, public works, and natural resources managers to make informed, cost effective decisions regarding the selection and application of appropriate dust control products with proven performance characteristics and maintenance requirements. The objective of this work was to produce a simple to use guidance document for dust control on roads, trails, and landing strips which summarizes, to the greatest extent possible, results from previous research that has experimentally documented (1) research site characteristics, (2) chemical composition of dust control products tested, (3) application rates and techniques, and (4) performance, durability, cost, and maintenance requirements. Summarized data was subsequently used to develop a dichotomous key that allows the user to select the most appropriate/environmentally acceptable dust control product based on site specific information such as climate, underlying soil types and textures, trafficked surface and aggregate material characteristics, vehicle type, anticipated traffic volumes, and length of service required.

14. SUBJECT TERMS
Dust Control, Unsurfaced Roadways, Landing Pads, Wheeled and Tracked Vehicles, Dust Pallatives, Roadway Construction and Maintenance, Water Application, Water Attracting Chemicals, Organic Nonbituminus Chemicals, Petroleum Based, Electrochemical, Polymers

15. NUMBER OF PAGES 31

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

DUST CONTROL GUIDANCE AND TECHNOLOGY SELECTION KEY

Prepared by the U.S. Army Construction Engineering Research Laboratories, Land Management Laboratory, Resource Mitigation and Protection Division; and the U.S. Army Engineer Waterways Experiment Station, Pavements Division.

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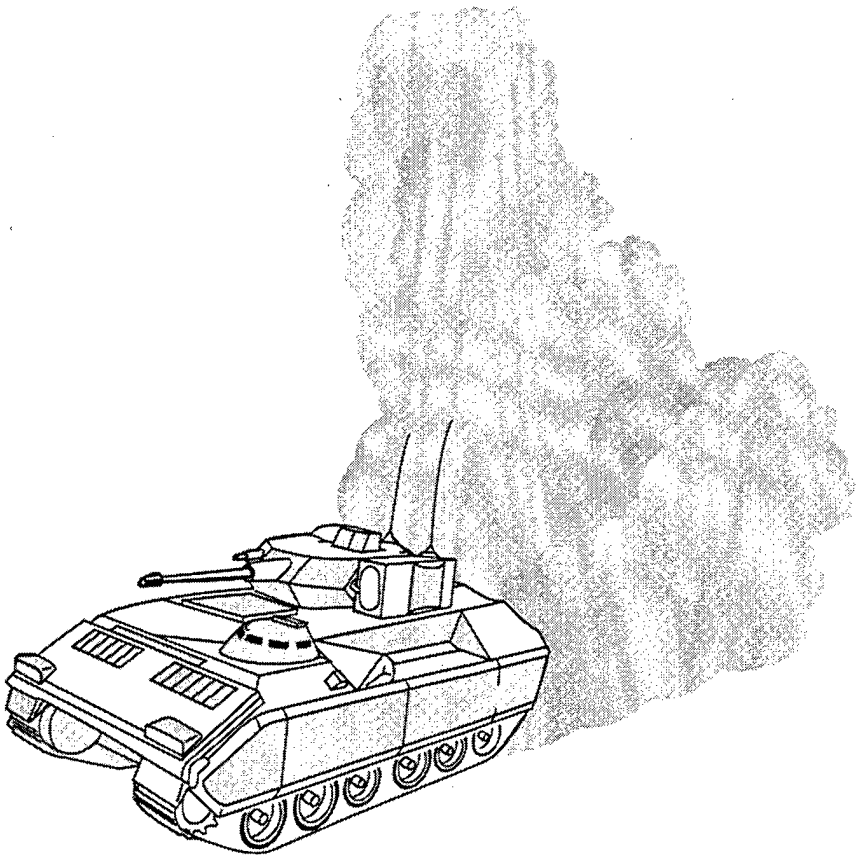

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ABSTRACT

Considerable research on dust control has been conducted by the U.S. Army Engineer Waterways Experiment Station, U.S. Army Construction Engineering Research Laboratories, product manufacturers, and other Federal and State agencies. However, results from this body of work have been published in a number of diverse and obscure documents that are largely unavailable or inaccessible to Army environmental, safety, public works, and natural resources managers. This lack of readily available information makes it difficult to make informed, cost-effective decisions for selecting and applying appropriate dust control products with proven performance characteristics and maintenance requirements.

This document provides guidance for dust control on roads, trails, and landing strips. It is a summary of the results from research that has experimentally documented:

- research site characteristics
- chemical composition of dust control products tested
- application rates and techniques
- performance, durability, cost, and maintenance requirements

Summarized data was subsequently used to develop a dichotomous key that allows the user to select the most appropriate/environmentally acceptable dust control product based on site-specific information such as:

- climate
- underlying soil types and textures
- trafficked surface and aggregate material characteristics
- vehicle type
- anticipated traffic volumes
- length of service required

FOREWORD

This project was conducted for the U.S. Army Environmental Center under Reimbursable Order number MIPR 6467, "Dust Control Summary and Guidance Documentation." The technical monitor was Ms. Kim Michaels, U.S. Army Environmental Center, Aberdeen Proving Ground, MD 21010-5401.

Personnel from the following organizations contributed valuable time, input, and review based on their collective experience and interest in military dust problems:

- U. S. Army Environmental Center
- U.S. Army Forces Command
- U.S. Army Training and Doctrine Command
- Combat Training Support Directorate

The work was managed by the Resource Mitigation and Protection Division (LL-R) of the Land Management Laboratory (LL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Dr. Dick L. Gebhart. Robert E. Riggins is Chief, CECER-LL-R; Dr. John T. Bandy is Operations Chief, CECER-LL; and Dr. William Severinghaus is the Technical Director.

BACKGROUND

Since 1946, the U.S. Army Corps of Engineers has been conducting a comprehensive research program on pavement maintenance, soil stabilization, and trafficability that includes companion studies investigating the development and evaluation of dust control materials on roads, trails, landing strips, and helipads. From 1966 to 1974, The U.S. Army Engineer Waterways Experiment Station (USAWES) pursued a program to identify suitable dust control materials for use in the Southeast Asia theater of operation. Numerous promising materials were developed from these efforts. During the mid-1980s, WES published results of several small-scale Facilities Technology Application Test (FTAT) demonstrations. These test produced procedures and techniques for dustproofing unsurfaced roads and other areas on military installations using common, industry-standard suppressants.

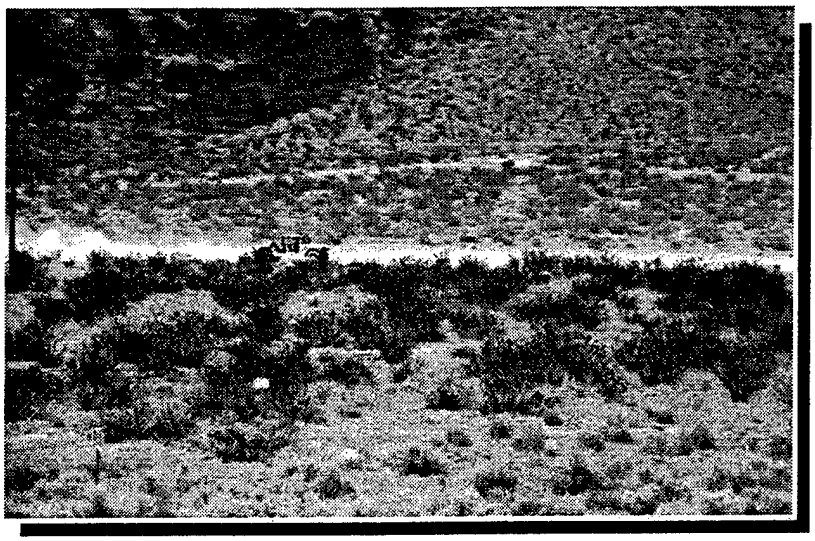
During the early 1980s, the U.S. Army Construction Engineering Research Laboratories (USACERL) began investigating fugitive dust and dust control in relation to National Air Quality Standard compliance issues. The primary objective of this work was to develop designs and monitoring criteria for the use of high-volume air sampling systems. These systems collect air quality data on total suspended and respirable particulate associated with various dust control techniques and training activities at Fort Carson, Colorado. During the early 1990s, WES conducted further investigations to develop new dust control materials and evaluate those that had become available since the related efforts of the 1960s, 1970s, and 1980s. Results of these studies suggested that equipment, manpower, and logistical requirements associated with the proper use of dust control materials could be reduced by at least 30 percent.

During FY96, USACERL, in cooperation with the U.S. Army Environmental Center (USAEC), demonstrated the performance, durability, and maintenance characteristics of several commercially available dust control products at Fort Hood, Texas, and Fort Sill, Oklahoma. Results from this demonstration project, a similar study at Fort Campbell, Kentucky, and the previous research conducted by WES, has provided the necessary data to begin summarizing and developing Army-wide guidance/smart-buyer documentation for dust control products.

In FY97, USACERL conducted additional research on dust control technologies as they relate to sandy soils at Fort McCoy, Wisconsin, and Fort Drum, New York. Results from these studies provided much-needed data on dustproofing and stabilizing sandy-textured soils in colder regions of the United States.

Data Requirements and Sources

A comprehensive literature review of existing dust control research and data resources was conducted to produce this dust control guidance and technology selection key. Sources for this review included:



- published research in scientific and popular journals and trade magazines
- manufacturing and service company product evaluations and promotional literature
- unpublished theses and dissertations from universities and colleges
- published and unpublished reports associated with Department of Defense entities such as Major Commands, research laboratories, and individual installations
- published and unpublished reports from other federal agencies such as the United States Department of Agriculture (Forest Service, Agricultural Research Service, and Natural Resources Conservation Service), the United States Department of the Interior (Bureau of Land Management, Bureau of Reclamation, Bureau of Indian Affairs, Environmental Protection Agency, and Fish and Wildlife Service), and the United States Department of Transportation
- published and unpublished reports from state and local agencies involved with transportation, agriculture, environmental quality/conservation, air quality, and natural resources management

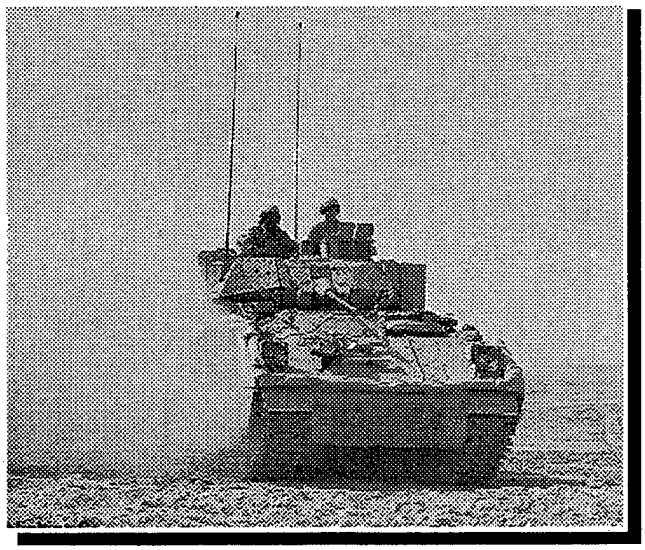
To ensure that the data used to develop this dust control guidance and technology selection key document were unbiased and reliable, careful attention was devoted to retrieving data that:

- provided descriptions of site characteristics such as climate, soil type/texture, surface characteristics, and traffic patterns
- identified the chemical composition of dust control products used
- reported application rates and techniques
- detailed how performance, durability, cost, and maintenance requirements were evaluated
- compared two or more types of products
- were quantitative in nature and clearly supported recommendations of one product over another

Literature meeting these requirements was then incorporated into a spreadsheet categorized by the above criteria.

INTRODUCTION

Excessive dust generation on unsurfaced roads, helicopter landing zones, firing lines, and assembly areas on military installations contributes significantly to reduced air quality and associated Clean Air Act compliance violations. It increases safety hazards, health problems, and the need for vehicle maintenance, and it reduces mission success. Dust can interfere with weapons targeting systems and landing clearance and may lead to unnecessary training delays. Dust generation is a preventable environmental problem; it can be controlled by proper road grading, surfacing, and maintenance practices. Preventing dust generation is a cost-effective way to avoid problems that can result in mission failure during training operations.



The purpose of this selection key is to provide guidelines for selecting the most cost-effective ways to control dust at military installations. Information contained herein is based on the most recent literature about dust control methods including personal interviews with experts from academia and state and federal transportation agencies. A dichotomous key was developed to assist with dust control decisions in a simple format that guides the user through a series of questions designed to provide a cost-effective solution to their dust control problems. The key is specifically designed for dust control on roadways, trails, and aircraft landing zones.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. This report is not to be construed as an official Department of the Army position unless so designated by other authorized documents.

DUST PROBLEMS

The main factors that lead to dust problems are loose surface materials and strong winds generated by atmospheric pressure changes and vehicle movement. Climatic factors, such as low rainfall and high temperatures, also contribute to dust problems such as those experienced in the arid and semi-arid regions of the U.S. Loose roadway surface materials are easily moved by winds. This results in surface degradation and enhanced dust generation because smaller particles (fines) necessary for proper bonding and surface strength have been eliminated. Eventually, this leads, to excessive road subsurface wear, thereby accelerating further destabilization. When a subgrade deteriorates, the road will require regrading, the addition of fines to promote surface bonding and strength, shaping, and compacting to create a hard surface layer and a properly crowned cross-section.

Frequently, only specific sections of roads, trails, and landing strips have problems with excessive dust generation and can be treated individually on an as-needed basis. Examples of such sections include road/trail intersections, road/trail segments close to high-speed paved roads or housing and administrative areas, and fuel and ammunition supply routes. This document specifically targets problem areas to ensure that valuable personnel, equipment, and material resources are not wasted on areas with only marginal dust problems.

The best way to avoid dust problems is to ensure that roads are properly maintained by surface grading and shaping for cross-sectional crowning to prevent excessive road surface wearing and consequent dust generation. Chemical dust suppressants are considered a secondary solution, to be used only when maintenance practices have been implemented to the greatest extent possible. The dichotomous key located in this document provides guidelines for determining whether chemical dust suppressants are warranted given predominant site-specific surface characteristics, soil types/textures, and climate and the type of vehicles used in a given area.

Reducing Dust Problems

Dust control methods can be categorized into three major types:

1. **Construction and Maintenance.** Good construction and maintenance practices are fundamental to providing durable and erosion-resistant trafficked surfaces in dust-prone areas. Properly crowned roadway cross-sections (referred to as geometry), well-graded materials composed of sufficient fines for strength and durability, and adequate drainage are vital to maintaining a hard surface that reduces dust emissions. Existing dust problem areas should be assessed to ensure that these basic factors are adequate.

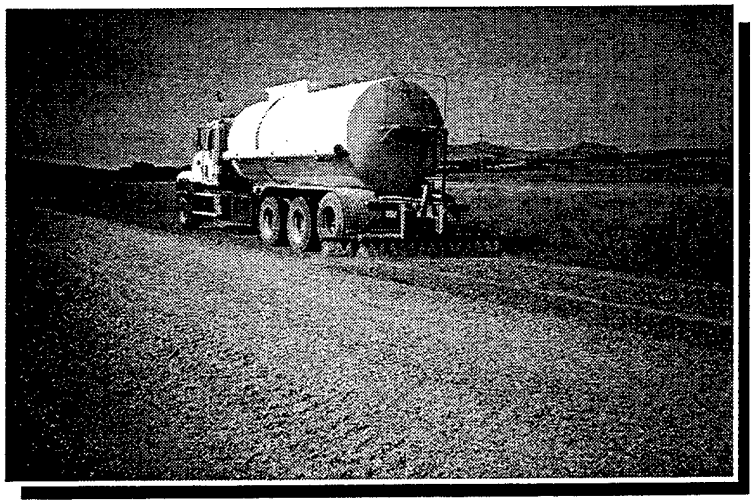
The choice of materials for the construction of aggregate-surfaced roads and airfields depends on whether or not frost is a design consideration. Materials should be sufficiently cohesive to resist abrasive action and should have a liquid limit no greater than 35 and a plasticity index of 4 to 9. These roads should be graded for maximum density and minimum volume of voids to optimumize moisture retention while resisting excessive water intrusion. The gradation, therefore, should consist of the optimum combination of coarse and fine aggregates that will minimize void ratios and maximize densities. Such materials will exhibit cohesive strength as well as inter-granular shear strength. Where frost is a consideration, a layering system should be used. The percentage of fines should be restricted in all layers to facilitate drainage and to ensure stability and strength during thaw periods.

Adequate surface drainage should also be provided to minimize moisture damage. Expeditious removal of surface water reduces the potential for absorption and ensures more consistent strength and reduced maintenance. Drainage, however, must be provided in a way that precludes damage to the aggregate-surfaced road or airfield through erosion of fines or the entire surface layer.

Roads require frequent maintenance because the environment and traffic deteriorate the aggregate surface. Rain or water flow will wash fines from the aggregate surface and reduce cohesion, while traffic action causes displacement of surface materials. Maintenance should be performed at least every six months and more frequently if required. Maintenance frequency will be high for the first few years of road use but will decrease over time to a more constant value. The majority of the maintenance will consist of periodic grading to remove the ruts and potholes that are inevitably created by the environment and traffic. Occasionally, the surface layer may have to be scarified and have aggregate added to maintain its original thickness. The wearing surface may also have to be recompacted to the originally specified density.

2. **Mechanical Stabilization.** Mechanical stabilization involves mixing of substrate materials to ensure that local soils have a wearing surface with correct grading and plasticity. A substrate that will considerably reduce dust generation is composed of well-graded gravel-sand mixtures with sufficient amounts of clayey (cohesive) fines to promote surface bonding and wear resistance. Mechanical stabilization can be used under a variety of conditions and, once established, will reduce dust emissions for years when properly maintained.

When a gravel road resists lateral displacement during traffic, it is said to be mechanically stable. This resistance is provided by the natural forces of cohesion and internal friction that exist in the soil. Cohesion is mainly associated with the fine silt and clay particles of the material, while internal friction is characteristic of the coarser particles. For a soil to be mechanically stable, it must fulfill requirements with respect to shear strength, resistance to abrasion, rigidity, incompressibility and freedom from swelling, shrinkage and frost action. Each of these conditions will vary with the soil material in the road and the loads applied to its structure.



Mechanical stabilization is accomplished by mixing soils of two or more gradations. The blending may take place at the construction site, a central plant, or a borrow area. After the soil is blended, it is spread and compacted to the required densities by conventional means.

3. **Chemical Palliatives.** Chemical dust palliatives should be considered as an adjunct to other dust control methods, especially if mechanical stabilization is cost-prohibitive and high dust generation persists. Chemical dust palliatives have a limited life span and require regular application to maintain adequate dust control on a long-term basis. Tracked vehicle traffic may reduce product performance standards by an estimated 50 percent to 75 percent or more. Careful consideration should be given to the life-cycle management of chemical dust suppressants since other dust control options may prove most cost-effective over time.

The methods described above should be applied in the order given. It may be necessary to employ all of these methods to reduce dust emissions to a satisfactory level. The use of dust palliatives is not recommended if intrinsic factors such as proper grading, drainage, and maintenance are inadequate. Cost-effective dust control measures depend heavily on proper maintenance and can significantly reduce the need for chemical dust palliatives.

Dust Palliatives

Chemical dust suppressants (palliatives) fall into the following general categories:

1. **Water-Attracting Chemicals [Chlorides, Salts, Brine Solutions]:** The dust palliatives in this category provide the most satisfactory combination of application ease, durability, cost, and dust control for semi-arid, semi-humid, and humid climates. Their effectiveness is limited, however, and may not provide sufficient dust control for a second year. Subsequent applications may be made at reduced rates because of residual effects.

   It should be noted that the products in this category are corrosive to metals and may not be acceptable if vehicle exposure to corrosive materials is not advisable or if relatively frequent vehicle washing is not possible.

2. **Organic, Non-Bituminous Chemicals [Lignosulfonates, Sulphite Liquors, Tall Oil Pitch, Pine Tar, Vegetable Oils, Molasses]:** These dust palliatives perform best under arid and semi-arid conditions, but are less effective on igneous, crushed gravel, and medium-to low-fine materials. As with water-attracting chemicals, the effectiveness of organic, non-bituminous chemicals is limited and may not provide sufficient dust control for a second year, but subsequent applications may be made at reduced rates because of residual effects. These materials fail after rains because organic, non-bituminous products have long curing times and are gradually leached out. Some of the commercial products in this product category may be visually unappealing, odorous, or very sticky upon application. This may preclude their use, depending on the location of the area to be treated.

3. **Petroleum-Based Binders and Waste Oils [Bitumin Emulsions, Asphalt Emulsions, and Waste Oils]:** The dust palliatives in this category are the most effective for a variety of climatic conditions. Unfortunately, waste oils can have significant adverse effects on the environment because they contain toxic materials. They are not environmentally acceptable unless they have been processed to remove these toxins. A number of asphalt emulsions, however, have been approved for use and, although relatively expensive compared to other product types, are considered effective for a broad range of soil types and climates. As with those in the organic, non-bituminous product category, some of these commercial products may also be visually unappealing, odorous, or very sticky upon application. This may preclude their use, depending on the location of the area to be treated.

4. **Electro-Chemical Stabilizers [Sulphonated Petroleum, Ionic Stabilizers, Bentonite]:** These products work over a wide range of climatic conditions, are least likely to leach out, and are particularly effective on clayey or sandy surface materials. A large variety of these materials are available to road construction and maintenance engineers and, when applied under highly specific trafficked-surface and aggregate conditions, have been shown to reduce dust generation dramatically. Unlike most traditional dust palliatives, however, these products have no standard laboratory tests for predicting their performance under field conditions and their use often results in either unqualified success or utter failure. Until standard testing is developed for the products in this product category, small-scale trials should be initiated and evaluated for efficacy prior to large-scale application.

5. **Polymers [Polyvinyl Acrylics and Acetates]:** These products bind surface soil particles together and form a semi-rigid film on the trafficked surface. Most polymer products are supplied in concentrated form and require dilution with water before application. With slight variations in dilution and final application rates, polymers are generally suitable for use under a wide range of soil and climatic conditions. Unlike some of the other product types, most polyvinyl acrylics and acetates are considered non-toxic and environmentally friendly when used according to manufacturers' recommendations. They are most effective on lightly trafficked surfaces such as helicopter landing surfaces in arid, semi-arid, semi-humid, and humid zones that receive between 8 and 40 inches of precipitation per year.

6. **Microbiological Binders [Cryptogams, Blue-Green Algae Inoculants, Enzyme Slurries]:** This category is especially important in arid climates, as cryptogams bind soil particles together, thereby reducing the movement of dust particles. Inoculants that can be applied easily and evenly are currently under development. Many enzymes are adsorbed by clay particles, resulting in a compression of the pore space that aids in compaction and reduces dust generation. As with those in the electro-chemical stabilizer category, these products have been very successful under highly specific trafficked-surface and aggregate conditions. Without standard testing procedures to predict their performance under field conditions, small-scale trials should be initiated and evaluated for efficacy prior to large-scale application.

Depending on the state in which the installation is located, there may be limitations as to which product category can be used. Prior to actually applying any dust palliative, it is imperative to determine whether there are any regulatory limitations concerning its use. Most state departments of transportation, environmental quality, or environmental conservation can provide details concerning the application of specific dust palliatives. For example, the state of New York prohibits the use of salts (Calcium Chloride, Magnesium Chloride) within 100 feet of regulated wetlands and limits yearly application rates for non-wetland areas. Always obtain a record of environmental consideration or other similar document prior to purchasing and applying any dust palliative.

It is also important to note that similar products within a given product category are not necessarily equal in terms of performance, durability, cost, and ease of application. Vendors capable of providing services both to supply and apply dust palliatives are also not necessarily equal in terms of reliability, timeliness, and adherence to application specifications. Because the mention of specific trade names could be perceived as exclusionary by competing vendors, it is the user's responsibility to ascertain whether a given vendor or product trade name can provide high quality results or services. For this reason, references pertaining to each product category derived from the use of the dichotomous key can be found at the end of this document. These references will often cite specific products by trade name, which will aid the user in identifying products with proven performance characteristics.

Guidelines for Dust Control

Construction of New Roadway Surfaces

The best way to provide long-term dust control is through the proper design and construction of new roads, trails, and landing zones. Special consideration should be given to the following:

- proper crown in the subgrade to assist in preserving a uniform thickness of surface material across the trafficked area
- proper crown of the wearing surface to ensure effective surface drainage to minimize the loss of fines and the potential for leaching of chemical dust palliatives
- compaction of the subgrade and pavement material to minimize particle movement

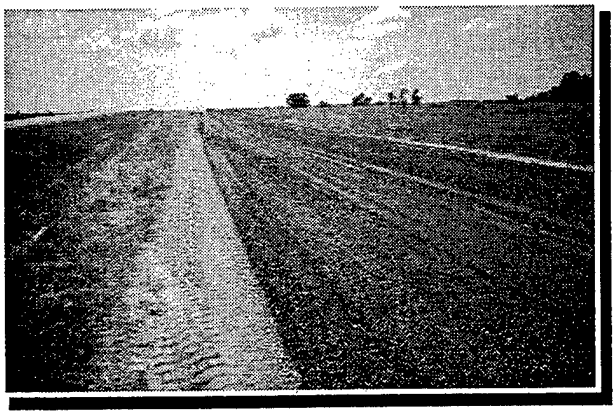
Water Application

Spraying water on a problem area usually gives immediate results and is an inexpensive method of short-term dust control. Water surrounds and adheres to dust particles, making movement more difficult. However, the effectiveness of water application is short-lived and may cause the pumping of fines to the wearing surface under continual wetting conditions. In arid climates, conservation of water may be regulated in such a way as to prohibit this method. Application of water is only recommended as a short-term solution to dust emission problems.

Maintenance of Existing Roadway Surfaces

Regular maintenance of existing roads and landing zones is the most cost-effective method of controlling dust emissions at a military installation. Maintenance activities should include:

- use of well-graded aggregates having adequate cohesive binder (fines)
- retention of the crown to provide adequate drainage
- adequate drainage of the wearing surface, shoulder and verge
- proper compaction of the wearing surface following the addition of aggregate and grading. Compaction increases the density and strength of the wearing surface and retention of larger aggregates.
- little or no maintenance grading during dry weather



USE OF CHEMICAL DUST PALLIATIVES

The following key is designed to allow a military installation that is experiencing dust control problems to evaluate various solutions. If warranted, chemical dust palliative categories are recommended based on vehicular traffic volume, climatic factors, and soil types/textures. The recommended palliative categories are those that have shown the best results in empirical studies and in surveys of current literature. Product performance standards cited in the references may be reduced by an estimated 50 to 75 percent if tracked-vehicle traffic predominates.

By working through the questions in the key, the most effective chemical dust palliative can be determined for conditions at a given installation. Once the proper palliative category has been established, application rates and concentrations are available from commercial manufacturers of the various products. Information regarding the cost-effective application of chemical dust palliatives on a military installation can be found in:

- USACERL Technical Report No. 97/69. Gebhart and Hale. 1997.
- USAEC/USACERL Technical Report No. SFIM-AEC-ET-CR-96196. Gebhart and Hale. 1996.
- *Dustproofing Unsurfaced Areas: Facilities Technology Application Test Demonstrations, FY 84.* CEWES Technical Report GL-85-11. Styron III, et. al. 1985.
- *Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 85.* CEWES Technical Report GL-86-20. Robert A. Haas. 1986.
- *Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 86.* CEWES Miscellaneous Paper GL-87-19. Jeffrey P. Armstrong. 1987.
- *Consumers Guide to Dust Control Technologies.* J.P. Zaniewski and A.K. Bennett. 1989.

TO MAKE THE MOST EFFECTIVE USE OF THIS KEY, THE FOLLOWING DATA SHOULD BE READILY AVAILABLE:

- predominant type of traffic the area supports
- estimated traffic volume during the periods of most intense use
- characteristics of the trafficked surface including surface geometry, materials used for its construction, drainage patterns, and maintenance schedules, all of which should be readily available from the Roads and Grounds division of the Directorate of Public Works
- average annual precipitation
- predominant soil texture of the trafficked surface.

Dust Palliative Dichotomous Key

1. Has the area been identified as having a dust control problem?
   a. Yes — Go to 2
   b. No

2. Does the area support military vehicle traffic?
   a. Yes — Go to 3
   b. No

3. Does the area support aircraft traffic?
   a. Yes — Go to 4
   b. No — Go to 6

4. Is the type of aircraft fixed-wing?
   a. Yes — Go to 10
   b. No — Go to 5

5. Are the aircraft helicopters?
   a. Yes — Go to 43
   b. No — Go to 3

6. Does the area support land vehicles?
   a. Yes — Go to 7
   b. No — Go to 14

7. Are the vehicles tracked or wheeled?
   a. Tracked — Go to 9
   b. Wheeled — Go to 8

8. Estimated number of wheeled vehicle passes per day during periods of heaviest use:
   a. More than 250 — Go to 11
   b. Less than 250 — Go to 13

9. Estimated number of tracked vehicle passes per day during periods of heaviest use:
   a. More than 100 — Go to 11
   b. Less than 100 — Go to 13

10. Estimated number of aircraft landings per day during periods of heaviest use:
    a. More than 50 — Go to 14
    b. Less than 50 — Go to 13

11. Are permanent surface treatments, such as paving, economically feasible? Paving costs are about $6 to $10 per square yard, but can be significantly higher if predominantly tracked-vehicle traffic is expected because thicker pavement is required for satisfactory performance.
    a. Yes — Go to 12
    b. No — Go to 14

12. Apply permanent stabilization practices. Paving the surface will be more cost-effective than periodic unsurfaced road maintenance and regular application of dust suppressants.

13. The use of chemical dust suppressants may not be economically justified based on low traffic volumes; good construction and maintenance practices are recommended instead. However, when safety or air quality concerns are a high priority, low traffic volumes should not preclude the use of chemical dust suppressants. Go to 14

14. Has the surface been evaluated for geometry, materials, drainage, and maintenance practices?
    a. Yes — Go to 20
    b. No — Go to 15

15. Does the geometry of the surface appear to have a crown that facilitates drainage?

    a. Yes — Go to 16

    b. No — Go to 19

16. Do surface and subsurface materials appear to be stable and without significant potholing, washboarding, or other forms of erosion?

    a. Yes — Go to 17

    b. No — Go to 19

17. Does the surface have adequate drainage for local conditions?

    a. Yes — Go to 18

    b. No — Go to 19

18. Is surface maintenance performed on a regular basis?

    a. Yes — Go to 20

    b. No — Go to 19

19. Upgrades to drainage, surface and subsurface materials, grading, and/or maintenance practices may solve the dust control problem. Chemical dust suppressants should be considered if mechanical stabilization is not cost-effective and/or dust problems persist. Mechanical stabilization, which may include the addition, grading, mixing, and compaction of fresh aggregate materials, costs about $2 to $3 per square yard. Most installation Directorate of Public Works and State Department of Transportation departments can provide detailed information about mechanical stabilization practices and specifications.

    Go to 20

20. Determine dominant climate influences, trafficked-surface soil textures, and suitable dust control product categories. Go to 21

21. The climate of the installation is classified as:

    a. Arid *(less than 12" of precipitation per year)* — Go to 22

    b. Temperate *(12"-36" of precipitation per year)* — Go to 23

    c. Humid *(more than 36" of precipitation per year)* — Go to 30

22. Soil texture of the trafficked surface is best classified as:

    a. Sand/gravel — Go to 24

    b. Loam — Go to 25

    c. Clay — Go to 26

    d. Limestone — Go to 27

23. The temperate climate is classified as:

    a. Semi-arid *(12"-24" of precipitation per year)* — Go to 28

    b. Sub-humid *(24"-36" of precipitation per year)* — Go to 29

24. Recommended product category for the trafficked surface:

    Primary: *Organic, Non-bituminous* — Go to 43

    see references 1, 20, 37

    Secondary: *Salts or Petrol* — Go to 43

    see references 1, 4, 20, 31, 37

25. Recommended product category for the trafficked surface:

    All product categories are suitable. — Go to 43

    see references 10, 20, 31, 35

26. Recommended product category for the trafficked surface:

    Primary: *Organic, Non-bituminous* — Go to 43

    see references 20, 37

    Secondary: *Salts or Electro-chemical Stabilizers* — Go to 43

    see references 31, 35

27. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 43

see references 31, 37

Secondary: *Organic, Non-bituminous* Go to 43

see references 20, 37

28. Soil texture of the trafficked surface is best classified as:

a. Sand/gravel Go to 31

b. Loam Go to 32

c. Clay Go to 33

d. Limestone Go to 34

29. Soil texture of the trafficked surface is best classified as:

a. Sand/gravel Go to 35

b. Loam Go to 36

c. Clay Go to 37

d. Limestone Go to 38

30. Soil texture of the trafficked surface is best classified as:

a. Sand/gravel Go to 39

b. Loam Go to 40

c. Clay Go to 41

d. Limestone Go to 42

31. Recommended product category for the trafficked surface:

Primary: *Petrol* Go to 44

see references 10, 35

Secondary: *Organic, Non-bituminous* Go to 44

see reference 20

32. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 44

see references 1, 2, 10, 25, 27, 28, 32, 36

Secondary: *Organic, Non-bituminous* Go to 44

see references 1, 2, 6, 10, 20, 25, 32, 36

33. Recommended product category for the trafficked surface:

Primary: *Organic, Non-bituminous* Go to 44

see references 6, 20, 30

Secondary: *Petrol* Go to 44

see reference 20

34. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 44

see references 18, 28

Secondary: *Organic, Non-bituminous* Go to 44

see references 18, 30

35. Recommended product category for the trafficked surface:

Primary: *Organic, Non-bituminous* Go to 44

see references 3, 11, 12, 13, 33

Secondary: *Salts* Go to 44

see references 18, 21

36. Recommended product category for the trafficked surface:

Primary: *Organic, Non-bituminous* Go to 44

see references 3, 11, 12, 13, 16, 20, 23, 24, 33, 36

Secondary: *Salts* Go to 44

see references 3, 11, 12, 13, 16, 21, 24, 29, 36

37. Recommended product category for the trafficked surface:

Primary: *Organic, Non-bituminous* Go to 44

see references 11, 12, 13, 20, 23, 24

Secondary: *Electro-chemical Stabilizers* Go to 44

see reference 7

38. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 44

see references 8, 15, 18, 21

Secondary: *Organic, Non-bituminous* Go to 44

see references 15, 23

39. Recommended product category for the trafficked surface:

Primary: *Petrol* Go to 44

see references 20, 29

Secondary: *Organic, Non-bituminous* Go to 44

see references 14, 18

40. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 44

see references 16, 31

Secondary: *Electro-chemical Stabilizers* Go to 44

see reference 29

41. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 44

see references 4, 14, 20, 29

Secondary: *Organic, Non-bituminous* Go to 44

see references 14, 20

42. Recommended product category for the trafficked surface:

Primary: *Salts* Go to 44

see references 4, 16, 17, 18

Secondary: *Organic, Non-bituminous* Go to 44

see references 16, 17, 18

43. Recommended product category for the trafficked surface:

Primary: *Polymers* Go to 44

see references 17, 20

Secondary: *Petrol* Go to 44

see reference 20

44. The economic evaluation for prolonged and repeated use of this product at 60- to 90-day intervals is:

a. Economical Go to 45

b. Not economical Go to 46

45. A trial application of the product category has proven:

a. Effective Go to 47

b. Not effective Go to 46

46. Consider paving or use of an alternate dust palliative.

47. Implement large-scale use of product category and a monitoring program.

REFERENCES

NOTE: *Order of product details are:* PRODUCT CATEGORY: product type; concentration; application rate; durability of performance in days for predominately wheeled vehicle traffic; reduce performance by 50 ro 75 percent for predominatly tracked-vehicle traffic

1. Addo, J.Q., and T.G. Sanders. 1995. Effectiveness and environmental impact of road dust suppressants. Mountain-Plains Consortium Report Number 95-28A, North Dakota State University.
   SALTS: 32 percent MgCl; 0.25 gal/sq yd; 140 days.
   ORGANIC NON-BITUMINOUS:
   25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 140 days.

2. Apodaca, M., and D. Huffmon. 1990. Dust abatement review and recommendations. USDA Forest Service-Gifford Pinchot National Forest.
   SALTS: 35 percent CaCl; 0.25 gal/sq yd; 70 days.
   ORGANIC NON-BITUMINOUS:
   25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 70 days.

3. Aquin, R., P. Korgemagi, and D.F. Lynch. 1986. Evaluation of Tembind 35 dust palliative, Ontario Ministry of Transportation and Communications. M1-83 Report.
   SALTS: 32 percent CaCl; 0.50 gal/sq yd; 90 days.
   ORGANIC NON-BITUMINOUS:
   35 percent solids ammonium lignosulfonate; 0.50 gal/sq yd; 70 days.

4. Armstrong, Jeffery P. 1987. "Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 86." Miscellaneous Paper GL-87-19/ADA185185, U.S. Army Waterways Experiment Station.
   SALTS: 32 percent MgCl; 0.50 gal/sq yd; 60 days.
   SALTS: 38 percent CaCl; 0.35 gal/sq yd; 60 days.

5. Bassel, J.R. 1992. A demonstration of a dust palliative. USDA, Forest Service, Technology and Development Program, Roads Tech Tips, May 1992.
   PETROLEUM: Asphalt emulsion;
   5:1 water:product ratio;
   0.60 gal/sq yd; 75 days.

6. Bennett, D.M. and K. Gleeson. 1995. Performance evaluation of tall oil pitch emulsion for stabilizing unpaved forest road surfaces. sixth international Conference on Low-Volume Roads, Transportation Research Board, pp. 213-224.
   ORGANIC NON-BITUMINOUS:
   Tall oil pitch emulsion; 1:3 water:product ratio; 2.08 gal/sq yd; 90 days.

7. Bergeson, K.L. and S.G. Brocka. 1995. Bentonite treatment for fugitive dust control. Sixth International Conference on Low Volume Roads, Vol. 2., Transportation Research Board, Washington, DC, National Academy Press.
   ELECTROCHEMICAL: Bentonite clay;
   7-9 percent w:w ratio or 126-162 tons/mile; 365 days.

8. Bergeson, K.L., J.W. Wadingham, S.G. Brocka, and R.K. Lapke. 1995. Bentonite treatment for economical dust reduction on limestone-surfaced secondary roads. Highway Division, Iowa Department of Transportation and Iowa Highway Research Advisory Board, Project HR-351.
   SALTS: 32 percent CaCl; 0.50 gal/sq yd; 180 days.

9. Bergeson, K.L., and A.M. Wahbeh. 1990. Development of an economic dust palliative for limestone-surfaced secondary roads. Final report. Iowa Department of Transportation, Research project HR-297.
   ELECTROCHEMICAL: Bentonite clay;
   8 percent w:w ratio or 150 tons/mile; 365 days.

10. Bolander, P. 1989. Chemical additives for dust control. Transportation Research Record 1589:42-49.
SALTS: 32 percent MgCl; 0.75 gal/sq yd; 60 days.
ORGANIC NON-BITUMINOUS:
25 percent solids ammonium lignosulfonate; 0.75 gal/sq yd; 60 days.
PETROLEUM: Asphalt emulsion;
5:1 water:product ratio; 0.80 gal/sq yd; 60 days.
Order of product details are: PRODUCT. CATEGORY: Product type; concentration; application rate; durability of performance in days for predominantly wheeled vehicle traffic; reduce performance by 50 to 75 percent for predominantaly tracked-vehicle traffic.

11. Boyd, K.R. 1983a. Evaluation of calcium lignosulfonate as a dust palliative, Report 2, Manitoba Department of Highways and Transportation.
SALTS: 35 percent CaCl; 0.50 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.44 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids sodium lignosulfonate; 0.44 gal/sq yd; 90 days.

12. Boyd, K.R. 1983b. Evaluation of calcium lignosulfonate as a dust palliative, Report 3, Manitoba Department of Highways and Transportation.
SALTS: 35 percent CaCl; 0.50 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.44 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids sodium lignosulfonate; 0.44 gal/sq yd; 90 days.

13. Boyd, K.R. 1986. Summary of the 1985 lignosulfonate evaluations, Manitoba Department of Highways and Transportation, Materials and Research.
SALTS: 35 percent CaCl; 0.50 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.44 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids sodium lignosulfonate; 0.44 gal/sq yd; 90 days.

14. Brown, D.A., and D.J. Elton. 1994. Guidelines for dust control on unsurfaced roads in Alabama, Final report IR-94-02, Alabama Highway Research Center, Auburn University.
SALTS: 35 percent CaCl; 0.66 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 1.00 gal/sq yd; 90 days.

15. Cleghorn, H.P. 1992. Dust control and compaction of unpaved roads-field trials. MAT-92-02. Research and Development Branch, Ontario Ministry of Transportation.
SALTS: 35 percent CaCl; 0.35 gal/sq yd; 30 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 30 days.

16. Gebhart, D.L., T. A. Hale, and K. Michaels-Busch. 1996. Dust control material performance on unsurfaced roads and tank trails. Technical report SFIM-AEC-ET-CR-96196, United States Army Environmental Center, Aberdeen Proving Ground, MD.
SALTS: 38 percent CaCl; 0.50 gal/sq yd; 60 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 60 days.

17. Gebhart, D.L., and T.A. Hale. 1997. Effectiveness of dust control agents applied to tank trails and helicopter landing zones. Technical report 97/69, United States Army Construction Engineering Research Laboratories, Champaign, IL.
SALTS: 38 percent CaCl; 0.50 gal/sq yd; 90 days.
ORGANIC NON-BITUMINOUS: 50 percent solids soybean oil; 0.40 gal/sq yd; 90 days.
POLYMERS: Polyvinyl acrylic; 7:1 water to product ratio; 1.0 gal/sq yd; 90 days.

18. Gebhart, D.L. 1997. Effectiveness and durability of several dust control agents on unsurfaced roads and trails at Fort McCoy, Wisconsin. Letter report to ITAM Coordinator, Fort McCoy.
SALTS: 38 percent CaCl; 0.50 gal/sq yd; 120 days.

19. Gebhart, D.L. 1997. Effectiveness, durability, and costs associated with several dust control agents on unsurfaced roads at Fort Drum, New York. Letter report to ITAM Coordinator, Fort Drum.
SALTS: 38 percent CaCl; 0.50 gal/sq yd; 120 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 90 days.
Order of product details are: PRODUCT. CATEGORY: Product type; concentration; application rate; durability of performance in days for predominantly wheeled-vehicle traffic; reduce performance by 50 to 75 percent for predominantly tracked-vehicle traffic.

20. Grau, R.H. 1993. "Evaluation of Methods for Controlling Dust." Technical report L-93-25, U.S. Army Waterways Experiment Station.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 2.00 gal/sq yd; 270 days.
PETROLEUM: Petroleum resin emulsion; 0.25 gal/sq yd; 270 days.
PETROLEUM: Petroleum resin emulsion; 0.25 gal/sq yd; 270 days.
POLYMERS: Polyvinyl acrylic; 5:1 water to product ratio; 1.0 gal/sq yd; 180 days.

21. Hass, R.A. 1985. "Dustproofing Unsurfaced Tank Trails at Grafenwohr Training Area, Federal Republic of Germany, June 15-29, 1985," Miscellaneous paper GL-86-40, U.S. Army Waterways Experiment Station.
SALTS: 32 percent MgCl; 0.60 gal/sq yd; 120 days.

22. Hass, Robert A. 1986. "Dustproofing Unsurfaced Areas: Facilities Technology Application Test (FTAT) Demonstration, FY 85." Technical report GL-86-20/ADA176861, U.S. Army Waterways Experiment Station.
SALTS: 32 percent MgCl; 0.80 gal/sq yd; 60 days.

23. Highway Extension Research Project: Indiana Counties and Cities. 1992. Purdue University, 10(4):10-11.
ORGANIC NON-BITUMINOUS:
30 percent solids beet molasses; 0.50 gal/sq yd; 180 days.

24. Hoover, J.M., D.E. Fox, M.T. Lustig, and J.M. Pitts. 1981. Mission-oriented dust control and surface improvement processes for unpaved roads. Final report, Iowa Highway Research Board Project, H-194.
SALTS: 38 percent CaCl; 0.25 gal/sq yd; 100 days.
ORGANIC NON-BITUMINOUS:
25 percent solids ammonium lignosulfonate; 0.25 gal/sq yd; 100 days.

25. Kolot, J.B. 1984. Report on dust treatment test sections. Saskatchewan Highways and Transportation internal report.
SALTS: 30 percent CaCl; 0.50 gal/sq yd; 120 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 120 days.

26. Marks, V.J., and G. Petermeier. 1997. Let me shingle your roadway. Interim report, Iowa Department of Transportation, Research Project HR-2079.
PETROLEUM: Ground roofing shingles; 1000 tons/mile, 365 days.

27. Marshall, S.C. 1997. Effectiveness of calcium chloride on road dust suppression and effects on roadside water and soil. M.A. thesis, University of Wyoming.
SALTS: 42 percent CaCl; 0.50 gal/sq yd; 90 days.

28. Monlux, S. 1993. Dust Abatement Product Comparisons in U.S. Forest Service Region One. Internal report, USFS, Region 1, Missoula, MT.
SALTS: 29 percent MgCl; 0.50 gal/sq yd; 100 days.
PETROLEUM: Asphalt emulsion; 0.39 gal/sq yd; 60 days.

29. Muleski, G.E., and C. Cowherd. 1987. Evaluation of the effectiveness of chemical dust suppressants on unpaved roads. Midwest Research Institute. EPA report number 600/2-87/102.
SALTS: 38 percent CaCl; 0.82 gal/sq yd; 60 days.

PETROLEUM: Petroleum emulsion;
5:1 water:product ratio; 1.78 gal/sq yd; 60 days.
Order of product details are: PRODUCT. CATEGORY: Product type; concentration; application rate; durability of performance in days for predominantly wheeled-vehicle traffic; reduce performance by 50 to 75 percent for predominantly tracked-vehicle traffic.

30. Sontowski, D., and L. Vliet. 1977. Lignosulfonate dust palliative evaluation. Geotechnical and Materials Branch, Ministry of Highways and Public Works, Victoria, British Columbia.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 60 days

31. Styron, C.R., R.A. Hass, and K. Kelley. 1985. "Dustproofing unsurfaced areas; facilities technology application test demonstrations, FY84," Technical report GL-85-11, U.S. Army Waterways Experiment Station.
SALTS: 32 percent MgCl; 0.50 gal/sq yd; 60 days.

32. Tetteh-Wayoe, H. 1982. Evaluation of M+F road stabilizer on gravel roads. Research and Development Branch, Alberta Ministry of Transportation.
SALTS: 32 percent CaCl; 0.50 gal/sq yd; 120 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 120 days.

33. Troedsson, K. 1994. Hot on the trail of a new dust control product:soybean soapstock. Minnesota Technology Exchange, University of Minnesota, 2(2):3-4.
PETROLEUM: 50 percent solids soybean oil; 0.25 gal/sq yd; 180 days.

34. Unger, M. 1990. Investigation of relationship of visible emissions to TSP/PM10 control eficiency. Indiana Department of Environmental Management/Indiana University Northwest.
PETROLEUM: Petroleum emulsion;
5:1 water:product ratio; 0.70 gal/sq yd; 75 days.

35. Watson, J.G., J.C. Chow, J.A. Gillies, H. Moosmuller, C.F. Rogers, D. DuBois, and J. Derby. 1996. Effectiveness demonstration of fugitive dust control methods for public unpaved roads and unpaved shoulders on paved roads. Final Report 685-5200.1F1, Desert Research Institute.
PETROLEUM: Non-hazardous crude oil; 0.50 gal/sq yd; 365 days.
PETROLEUM: Petroleum emulsion;
5:1 water:product ratio; 0.50 gal/sq yd; 120 days.

36. Westway Trading Corporation. 1997. Road dust control with soapstock-A soybean oil by-product.
SALTS: 30 percent CaCl; 0.50 gal/sq yd; 180 days.
ORGANIC NON-BITUMINOUS:
35 percent solids soybean oil; 0.25 gal/sq yd; 180 days.

37. Zaniewski, J.P., and A.K. Bennett. 1989. Consumer's guide to dust control technologies. Center for Advanced Research in Transportation, College of Engineering and Applied Sciences, Arizona State University.
SALTS: 35 percent MgCl; 0.50 gal/sq yd; 60 days.
SALTS: 32 percent MgCl; 0.50 gal/sq yd; 60 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 60 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 60 days.
ORGANIC NON-BITUMINOUS:
25 percent solids sodium lignosulfonate; 0.50 gal/sq yd; 60 days.
ORGANIC NON-BITUMINOUS:
25 percent solids calcium lignosulfonate; 0.50 gal/sq yd; 60 days.
PETROLEUM: Petroleum emulsion;
5:1 water:product ratio; 0.75 gal/sq yd; 60 days.

Dust Control Product Costs and Vendor List

A range of material costs for each dust control product category is presented below. The lowest value of the range is for materials only and does not include labor, equipment, or application costs. The highest value of the range would be typical for having a contractor or vendor perform the work and includes all materials, labor, and equipment for application. Costs are presented on a volume or weight basis because differences in soil types influence dilution rates and final application rates. It should be noted that product costs can and will vary with transportation distances and product volumes required. For example, per-gallon costs associated with a 10,000-square-yard job will be higher than those associated with a 100,000-square-yard job. Some products, most notably those within the organic, non-bituminous category, are waste products from other industrial activities; their cost and availability will fluctuate with the magnitude of these industrial activities.

Dust Control Product Category	Cost Range
Salts, Brine Solutions	$0.20 to $1.00 per gallon
Organic, Non-Bituminous	$0.30 to $1.75 per gallon
Petroleum-Based	$2.00 to $10.00 per gallon
Electro-Chemical	$3.00 to $25.00 per gallon $40.00 to $130.00 per ton
Polymers	$1.50 to $8.00 per gallon

Disclaimer

The following list of dust control products and vendors is a compilation of information presented in current literature. The list is not intended to be complete and comprehensive for all vendors of dust control products, but merely reflects the most readily available data at the time of publication.

WATER-ATTRACTING CHEMICALS

Actin
1102 E. Columbus Drive
East Chicago, IN 46312
(219) 397-5020

All Construction
4327 Franklin, Suite 103
Michigan City, IN 46360
(219) 874-9474

Artesian Chemical Company & Supply, Inc.
P.O. Box 487
Brighton, CO 80601
(303) 659-6566

Ashland Chemical Company
P.O. Box 10298
Jackson, MS 39209
(601) 355-8383

B.S. & W. Energy Corporation
4745 N. 7th Street, Suite 440
Phoenix, AZ 85014
(602) 279-5000

California-Fresno Oil Company
P.O. Box 527
Fresno, CA 93709
(209) 486-0220

Cargill Solarchem Resources
P.O. Box 364
Newark, CA 94560

Chemical Distributors, Inc.
201 Bryce Court
Henderson, NV 89105
(702) 565-4904

Dust Pro
725 S. 12th Place
Phoenix, AZ 85034
(602) 251-3659

General Chemical Corporation
90 East Halsey Road
Parsippany, NJ 07054
(973)515-0900

Great Salt Lake Minerals & Chemicals
P.O. Box 1190
Ogden, UT 84402
(801) 731-3100

Hill Brothers Chemical Company
1675 N. Main Street
Orange, CA 92667
(714) 998 8800

Jim Good Marketing
P.O. Box 717
Shafter, CA 93263
(805) 746-3783

Kaiser Chemicals
30100 Chagrin Boulevard
Cleveland, OH 44124

Lee Chemical, Inc.
21250 Box Springs Road
Moreno Valley, CA 92387
(909) 369-5292

Leslie Salt Company
7200 Central Avenue
Newark, CA 94560
(415) 790-8169

Metamorphosis Hydroseeding, Inc.
1022A San Andreas Road
La Selva, CA 95076
(800) 994-7333

Midwest Industrial Supply, Inc.
P.O. Box 8431
Canton, OH 44711
(708) 941-0205

Nalco Chemical Company
One Nalco Center
Naperville, IL 60566-1024
(313) 961-9500

Nalco Chemical Company
4310 North 75th Street, Suite A
Scottsdale, AZ 85251
(602) 941-3915

PQ Corporation
ICD Sales Department
8401 Quartz Avenue
South Gate, CA 90280-2589
(213) 560-[illegible]1

PQ Corporation
P.O. Box 840
Valley Forge, PA 19482

Sahuaro Petroleum and Asphalt Company
1935 West McDowell Road
Phoenix, AZ 85005
(602) 252-3061

Sicalco Ltd.
5240 W. 123 Place
Alsip, IL 60658
(800) 942-4893

Soil Stabilization Products Company
P.O. Box 2779
Merced, CA 95344
(800) 523-9992

South Western Sealcoating, Inc.
23644 Adams Avenue
Murrieta, CA 92362
(714) 677-6228

Univer-SEAL Ltd.
3412 N. Nebraska Court
Chandler, AZ 85224
(602) 268-1233

Western Salt Company
7220 Trade Street, Suite 300
San Diego, CA 92121
(619) 566-6600

Western Spreading and Transportation, Inc.
641 Rock Springs Road
Escondido, CA 92025
(909) 784-7411

W&W Sales and Leasing Co.
P.O. Box 485
Edwardsville, IL 62025
(618) 656-5070

Organic, Non-Bituminous Chemicals

AET Group
655 Lewelling Boulevard
Suite 315
San Leandro, CA 94579
(209) 836-4884

Albright Seed Company
487 Dawson Drive Bay 55
Camarillo, CA 93012
(805) 484-0551

American Excelsior Company
8320 Canford Street
Pico Rivera, CA 90660-3702
(310) 949-2461

American Fiber Company
10820 Beverly Boulevard
Suite 322
Whittier, CA 90601
(310) 693-4072

Bartlett Services, Inc.
60 Industrial Park Road
Plymouth, MA 02360

Benetech, Inc.
1750 Eastwood Drive
Aurora, IL 60506

B.S. & W. Energy Corporation
4745 N. 7th Street, Suite 440
Phoenix, AZ 85014
(602) 279-5000

Cascadia Technologies, Ltd.
602-626 West Pander Street
Vancouver, B.C., Canada V6B1V9
(800) 665-2994

California-Fresno Oil Company
P.O. Box 527
Fresno, CA 93709
(209) 486-0220

Cellulose Resources Corporation
P.O. Box 1562
Escondido, CA 92025

C.E.T.I.
15568 Slover Avenue
Fontana, CA 92334
(909) 428-6861

Chem Shield
1475 E. Greg Street
Sparks, NV 89434
(702) 323-4540

Conkin Company, Inc
Building Products Division
P.O. Box 155
Shakopee, MN 55379
(612) 445-6010

C.S.S. Technology, Inc.
P.O. Box 1355
Weatherford, TX 76086

Desert Rock Supply
P.O. Box 924
La Quinta, CA 92253
(619) 360-1345

DeWitt Company
Highway 61 South
RR 3 Box 338
Sikeston, MO 63801

Diversified Services, Inc.
P.O. Box 337
Elizabethton, TN 37644
(615) 542-9100

Dust Bond of Arizona
4222 North 39th Avenue
Phoenix, AZ 85019
(602) 269-7891

Dust Pro
725 S. 12th Place
Phoenix, AZ 85034
(602) 251-3659

Dynaguard, Inc.
1034 N. Lemon Street
Orange, CA 92667
(714) 771-7411

Dynamis, Inc.
P.O. Box 397
Sanger, CA 93657
(209) 875-0800

Earth Systems International
28259 Dorothy Drive
Agoura Hills, CA 91301

Elloitt Landscaping
68-315 Durango Road
Cathedral City, CA 92234
(619) 320-0176

Energy Systems Associates
P.O. Box 976
McLean, VA 22101

EnviroCycle, Inc.
21992 Hiway 33
McKittrick, CA 93251
(800) 324-4484

Environmental Products and Applications Company
15017 Notnil Way
Lake Elsinore, CA 92530
(909) 674-9174

Environmental Soil Systems, Inc.
13234 Whistler Avenue
Granada Hills, CA 91344
(800) 368-4115

Envirosorb
1815 Wright Avenue
La Verne, CA 91750
(909) 392-5878

Erosion Control Systems, Inc.
1800 McFarland Boulevard North
Tuscaloosa, AL 35406

Executive Resource Associates
Suite 813, One Crystal Park
2011 Crystal Drive
Arlington, VA 22202

Feed Energy
3121 Dean Avenue
Des Moines, IA 50317
(515) 263-0408

Fiberwood
5854 88th Street
Sacramento, CA 95828
(800) 655-9754

Future Way Enviro Technologies, Inc.
13173 Amble Green Close
White Rock, British Columbia, Canada V4A6P9

Georgia-Pacific Corporation
P.O. Box 1236
Bellingham, WA 98227
(206) 733-4410

Georgia-Pacific Corporation
Western Chemicals
1426 Encino Avenue
Monrovia, CA 91016
(818) 445-8007

ITT Rayonier, Inc.
P.O. Box C-68967
18000 Pacific Highway South,
Suite 900
Seattle, WA 98188
(206) 246-3400 or (800) 228-0604

Midwest Industrial Supply, Inc.
P.O. Box 8431
Canton, OH 44711
(800) 321-0699

Native Soil Technology, Inc.
P.O. Box 502
Danville, CA 94526
(510) 837-5362

Ponderosa Systems, Inc.
P.O. Box 417
Sioux Falls, SD 57101
(605) 334-1100

Precision Hydroseeding Company
P.O. Box 12336
Palm Desert, CA 92255
(619) 360-2851

Prince Manufacturing Company
One Prince Plaza
P.O. Box 1009
Quincy, IL 62306
(217) 222-8854

RBJ Transport, Inc.
1735 N. Ashby Road
Merced, CA
(209) 722-2731

RDE, Inc.
101 North Virginia Street
Crystal Lake, IL 60014

R/M Sciences, Inc.
42353 Avenida Alvarado
Temecula, CA 92390

Sandcastle Hydroseeding
42529 8th Street East
Lancaster, CA 93535
(805) 723-0515

Sanders Hydroseeding, Inc.
1708 South Santa Fe
Santa Ana, CA 92705
(714) 973 8873

Soil Seal Corporation
3015 Supply Avenue
Los Angeles, CA 90040
(213) 727-0654

Soil Stabilization Products Company
P.O. Box 2779
Merced, CA 95344
(800) 523-9992

Southwest Chemical & Supply
5001 E. Washington St., Suite 100
Phoenix, AZ 85034
(602) 273-7533

S & S Seeds
P.O. Box 1275
Carpenteria, CA 93013
(805) 684-0436

Stabilizer, Inc.
4832 East Indian School
Phoenix, AZ 85018
(602) 952-8009

SWIFT Adhesives
2400 Ellis Road
Durham, NC 27703-5543
(800) 213-4804

United States Gypsum Company
Industrial Gypsum Division
P.O. Box 803871
Chicago, IL 60680-3871

Valley Products Company
384 E. Brooks Road
Memphis, TN 38109
(901) 396-9646

Western Emulsions, Inc.
Dust Control Division
22155 Big Timer Road
Moreno Valley, CA 92557
(909) 784-7411

Woodchem, Inc.
P.O. Box A
Oconto Falls, WI 54154
(414) 846-2839

PETROLEUM-BASED PRODUCTS

Actin
1102 E. Columbus Drive
East Chicago, IN 46312
(219) 397-5020

Betz Water Management Group
Big Valley District Office
4201 Ardmore Way, #7
Bakersfield, CA 93309
(805) 835-9194

Brown Industrial Process Corporation
P.O. Box 28155
San Diego, CA 92128

Diversey Corporation
(818) 961-6305

Energy Systems Associates, Inc.
P.O. Box 976
McLean, VA 22101

Environmental Products and Applications Company
15017 Notnil Way
Lake Elsinore, CA 92530
(909) 674-9174

Ergon Asphalts & Emulsions, Inc.
P.O. Box Drawer 1639
Jackson, MS 39215

Green Mountain, Inc.
4N250 Route 53
Addison, IL 60101

Morgan Emultech, Inc.
7200 Pit Road
P.O. Box 1500
Redding, CA 96099
(916) 241-1364

Pennzoil Products Company
12070 Telegraph Road, Suite 324
Santa Fe Springs, CA 90670
(310) 906-4300

Pragma, Inc.
P.O. Box 1658
Sutter Creek, CA 95685
(209) 267-5072

Witco Corporation
Golden Bear Division
P.O. Box 456
212 N. Chippewa
Chandler, AZ 85244-0161
(602) 963-2267

ELECTRO-CHEMICAL STABILIZERS

Amtrade, Inc.
8150 Holton Drive
Florence, KY 41042

Aqua Chemical Ltd.
P.O. Box 1138
Bakersfield, CA 93389
(805) 323-8308

Artesian Chemical Company & Supply, Inc.
P.O. Box 487
Brighton, CO 80601
(303) 659-6566

Compaction Compounds, Inc.
101 First Street, Suite 402
Los Altos, CA 94022
(415) 948-5900

Earth Systems International, Inc.
28259 Dorothy Drive
Agoura Hills, CA 91301

Gustafson, Inc.
1400 Preston Road, Suite 400
Plano, TX 75075

Martin Marietta Magnesia Specialties, Inc.
9308 Nickam Court
Bakersfield, CA 93311
(805) 663-0625

POLYMERS

Bartlett Services, Inc.
60 Industrial Park Road
Plymouth, MA 02360

Benetech, Inc.
1750 Eastwood Drive
Aurora, IL 60506

Boston/ASTC
521 Westminster Avenue
Newport Beach, CA 92663
(714) 646-1207

Brown Industrial Process Corporation
P.O. Box 28155
San Diego, CA 92128

Earth Systems International, Inc.
28259 Dorothy Drive
Agoura Hills, CA 91301

Eco-Polymers, Inc.
P.O. Box 4860
Cerritos, CA 90703-4860
(310) 407-3090

Executive Resource Associates, Inc.
Suite 813, One Crystal Park
2011 Crystal Drive
Arlington, VA 22202

J & M Land Restoration, Inc.
1640 James Road
Bakersfield, CA 93308
(805) 872-7039

Karleskint-Crum, Inc.
P.O. Box 5358
San Luis Obispo, CA 93403
(805) 543-3304

Midwest Industrial Supply, Inc.
P.O. Box 8431
Canton, OH 44711
(800) 321-0699

Reclamare Company
20727-7th Avenue South
Seattle, WA 98198
(206) 824-2385

Rohm and Haas Company
Toxicology Department
727 Norristown Road
P.O. Box 904
Spring House, PA 19477-0904
(215) 641-7000

S & S Seeds
P.O. Box 1275
Carpenteria, CA 93013
(805) 684-0436

Soils Control International, Inc.
P.O. Box 1214
Killeen, TX 76540
(817) 526-5550

Weather Tect., Inc.
9209 Seminole Boulevard, # 93
Seminole, FL 34642